RESTRICTED CIRCULATION

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AGRICULTURAL MEMORANDUM No.704

Metabolic Change Indices for some aphid species, and their parasites

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1. INTRODUCTION

The basic data examined are reported in

> "Temperature requirements of some aphids and their parasites" - Campbell et. al. (1974) J. appl. E col. Vol 11, No.2, pp. 431-8.

Table 1 from this paper is reproduced for convenience.

In the reference, for the field temperatures ranges likely to be experienced in practice, a linear relationship is postulated (and observed in the main) between temperature and rate of development. The straight line is characterised biologically in terms of a threshold temperature (t) and a time-to-adult (K), which is the number of degree days above (t) required by an insect to complete its development. (K) is in fact the reciprocal of the slope of the line.

2. DERIVED DATA

From the information provided it is possible to infer the development time, in days (D) at various (constant) temperatures; a metabolic change index I may also be calculated.

The results are shown in Tables 2.1 to 2.5.

3. DISCUSSION

This treatment does not invalidate conclusions from the original paper viz.

(1) The temperature requirements of some aphids differ from place to place for the same species, and from species to species.

(2) The temperature requirements of the parasites and hyperparasites associated with these aphids differ in a similar manner, but as a rule, are higher than those of their hosts.

The Metabolic Change index approach suggests -

(3) Over the broad central range of temperatures, bounded by temperatures between 10° - 15°C and 25° - 30°C, we may, for locally adapted species, identify a constant value of the index I and a constant value of Q_{10}. Outside of this broad central range of temperatures, lower values of Q_{10} for normal developmental processes are required, as has been demonstrated before (cf Ag Mem.696).

(4) The overall picture presented in Tables 2.1 - 2.5 suggests the requirement for a constant value of the index I for this developmental phase of apterous aphids, together with value of Q_{10} of 1.0 - 1.2 at 10°C,

may be used to "normalise" the time of development D at low temperatures; we may achieve a better working estimate of D at low temperatures than can be inferred directly from the original data.

(5) The most important point of this paper is not the presentation of information relevant to economically important species (other than Myzus persicae) in the UK.
Rather it is to emphasize insect and aphid phenology. Evolution and local adaptation present us with an ordered sequence of events in established and well adapted host-parasite relationships.

It would seem not unreasonable that outside of the direct host-parasite relationships examined there should be others; in particular, the idea should be explored that, in most seasons, certain insect species should act as precursors for others. Monitoring, as in the Rothamsted Insect Survey, could be turned into a early warning system, if suitable, and possibly unconnected species, could be used to foreshadow the arrival and logarithmic increase of the insects of direct consequence to a particular crop.

Meteorological Office,
Cambridge
February 1975.

TABLE 1 Thresholds (t ± S.E.) and times to adult (K ± S.E.) of apterous aphids, their parasites and hyperparasites at various locations.

Aphid hosts	t(°C)	K Day Degree C	Locality	Parasite	t(°C)	K Day Degree C
Acyrthosiphon pisum	5.1 ± 0.22	105 ± 2.2	Berkeley California	Aphidus Smithi	4.8 ± 0.49	172 ± 7.6
A. pisum	5.6 ± 0.11	104 ± 2.2	Kamloops British Columbia	A. erviervi	6.0 ± 0.08	197 ± 1.2
				A.e. pulcher	6.1 ± 0.08	188 ± 1.5
				A. Smithi	6.1 ± 0.08	180 ± 1.3
				Praon pequodorum	6.9 ± 0.09	199 ± 1.4
A. pisum	4.0 ± 0.28	118 ± 2.8	Vancouver	A. erviervi	4.2 ± 0.38	230 ± 10.2
Aphis craccivora	8.3	80	New South Wales			
Brevicoryne brassicae	7.1 ± 0.48	136 ± 7.2	Berkeley	Diaeretiella rapae	3.5 ± 1.43	241 ± 25.5
B. brassicae	5	127	Canberra	D. rapae	7	97 ± 3
B. brassicae	1.7	-	Tikkurila Finland			
B. brassicae	6.5	182	Wageningen	D. rapae	6.5	188
B. brassicae	4.7 ± 0.80	163 ± 11.4	Vancouver	D. rapae	4.9 ± 0.94	116 ± 9.4
Macrosiphon avenae	4.8 ± 0.61	117 ± 4.6	Vancouver			
Masonaphis maxima	3.9 ± 0.47	125 ± 5.0	Vancouver	Aphidus rubifolii	5.3 ± 0.41	176 ± 7.7
Parasite host				Hyperparasite		
A. Smithi	6.1 ± 0.08	180 ± 1.3	Kamloops	Dendrocerus niger	6.5 ± 0.11	184 ± 1.8
				Asaphes lucens	8.1 ± 0.22	233 ± 4.2

2.4. Species A. Smithi

Temperature	Base Location	4.8°C Berkeley			6.1°C Kamloops		
		D	I	Q_{10}	D	I	Q_{10}
10°C		33	34.7	1.1	46	-	-
15		17	34.7	2.0	20	37.8	2.0
20		11.5	35.0	2.0	13	36.1	2.0
25		8.5	34.7	2.0	9.5	35.9	2.0
30		7.0	37.1	1.9	7.5	36.6	1.9

2.5. Species A. niger

Temperature	Base Location	6.5°C Kamloops		
		D	I	Q_{10}
10		52.5	-	-
15		21.5	39.8	2.0
20		13.5	36.5	2.0
25		10.0	37.0	2.0
30		8.0	38.0	1.9

TABLE 2 Metabolic change indices for some data of Table 1

2.1 Species A. pisum

Temperature	Base Location 5.1°C Berkeley	5.6°C Kamloops	4.0°C Vancouver	4.0 Mean		
	D	D	D	D	I	Q10
10°C	21.4	23.6	19.6	21.5	24.1	1.2
15°C	10.6	11.0	10.7	11	24.2	2.0
20	7.0	7.2	7.4	7.5	24.0	2.0
25°	5.3	5.4	5.6	5.5	24.2	2.0

2.2. Species A. craccivora

Temperature	Base Location 8.0°C New South Wales		
	D	I	Q_{10}
15°	12	16.8	1.6
20°	7	16.4	2.0
25°	5	16.7	2.0
30°	3.5	16.4	2.0

2.3. Species B. Brassicae

Temperature	Base Location	7.1°C Berkeley			5.0°C Canberra			6.5°C Wageningen			4.7°C Vancouver		
		D	I	Q_{10}	D	I	Q_{10}	D	I	Q_{10}	D	I	Q_{10}
10°C		47	–	–	25.4	25.4	1.0	52	–	–	30.5	33.7	1.2
15		17	30.4	2.0	12.7	25.4	2.0	21.5	39.8	2.0	16.0	33.0	2.0
20		10.5	27.0	2.0	8.5	25.5	2.0	13.5	36.5	2.0	10.5	32.1	2.0
25		7.5	26.9	2.0	6.5	26.0	2.0	10.0	37.0	2.0	8.0	33.0	2.0
30		6.0	27.3	1.9	5.0	26.2	1.9	7.5	35.6	1.9	6.5	34.7	1.9